

March 2016

Minutes
IEA WIND Task 32 Workshop #1 on

**Floating Lidar Systems: Current Technology Status
and Requirements for Improved Maturity**

Date: February 23rd and 24th 2016

Venue: ORE Catapult, Blyth, UK

Workshop leader and lead author minutes: Julia Gottschall, Fraunhofer IWES

Further authors: Andrew Clifton, Jonathan Hughes, David Schlipf, Detlef Stein, Ines Würth

Agenda Overview

	Session 1 Presentations	Session 2 Presentations + discussion	Session 3 Presentations	Session 4 Working groups	Session 5 Discussion	
Inputs from participants	Introduction and background information	Overview of gaps and requirements	Technology review	Roadmaps	Merged roadmap	Technology report and roadmap
Before	Day 1		Day 2			After

Pre-workshop Activities

In advance to the workshop, two kinds of questionnaires were distributed to the (registered) participants: an online questionnaire with more general questions with regard to the technology's maturity and similar, and an excel sheet in which the Floating Lidar System (FLS) providers were asked to specify their technology in some detail. The outcomes of both surveys were presented and discussed in the course of the 2-day workshop.

Participant List

Name	Institution	Country
Adrian How	SSE	UK
Andrew Clifton	NREL	USA
Andy Paterson	Babcock International Group	UK
Arve Berg	Fugro OCEANOR AS	Norway
Benny Svardal	Christian Michelsen Research AS	Norway
Bernhard Lange	IWES Fraunhofer	Germany
Breanne Gellatly*	AXYS Technologies	Italy
Christian Jonsson	Natural Power	UK
David Langohr	Leosphere	France
David Schlipf	University of Stuttgart	Germany
Detlef Stein	DNV GL	Germany
Frank van Erp	Netherlands Enterprise Agency	The Netherlands
Hans Verhoef	ECN	The Netherlands
Hugo Herrmann	EDF Energy	UK
Ines Würth	University of Stuttgart	Germany
Jonathan Hughes	ORE Catapult	UK
Jorge García	EOLOS Floating Lidar Solutions	Spain
Julia Gottschall	IWES Fraunhofer	Germany
Matt Smith	ZepHIR Ltd	UK
Matthieu Boquet	Leosphere	France
Megan Smith	Carbon Trust	UK
Mikiko Sasaki	Mitsubishi Electric Corporation	Japan
Miriam Marchante Jiménez	Dong Energy	Denmark
Nobuki Kotake	Mitsubishi Electric Corporation	Japan
Peter Clive	SgurrEnergy	UK
Rob Newsom	Pacific Northwest National Laboratory	USA
Simon Toft Sorensen	Fraunhofer Centre for Applied Photonics	UK
Terry Tarle*	AXYS Technologies	Canada
Theodore Holtom	Wind Farm Analytics Ltd	UK
Thomas Lamant	EOLFI	France
Will Laird	SgurrEnergy	UK
Yutaka Kajiyama	Mitsubishi Electric Corporation	Japan

Participants of only one day of the workshop are marked by *.

Day 1 – Morning Session (Session 1)

The workshop was started with an introduction by the workshop leader. The objectives were itemized:

- workshop as a continuation of IEA Wind activities on Floating Lidar
- presentation of outcome from Task 32 Phase 1
- further technology review and update
- strong emphasis on the critical assessment of the technology's level of maturity and the identification of a possible roadmap to improved maturity

The workshop preparation team was introduced, and the participants were invited to present themselves and their stakeholder role.

Paul McKeever gave an introduction to ORE Catapult hosting the workshop.

David Schlipf presented the concept and plans for IEA Wind Task 32 Phase 2 and the frameworks of the workshop, respectively.

Detlef Stein summarized the Floating Lidar activities within Task 32 including the State-of-the-Art Report published just recently and follow-up activities of the corresponding author group.

The session was completed with the presentation of the outcome of the online questionnaire all participants had been asked to answer in advance to the workshop. In total, 18 participants had answered the questions with different stakeholder roles. An overview of the answers is available for download.

Day 1 – Afternoon Session (Session 2)

For the afternoon session, several workshop participants had been invited in advance to present their view on the technology, its maturity, corresponding technology gaps and related requirements to close the gaps. The presentations were grouped according to the different stakeholder roles. After each presentation the formulated gaps and requirements were written on a flipchart.

Megan Smith started with a presentation of the OWA activities on Floating Lidar.

Hugo Herrmann and Miriam Marchante Jiménez presented the view(s) of an end-user of the technology.

Detlef Stein, together with Hans Verhoef, and Peter Clive looked at the technology from the side of a consultant.

After a coffee/tea break the session was continued with the views of the different lidar providers that are active in the market – Matt Smith for ZephIR, David Langohr for Leosphere and Nobuki Kotake for Mitsubishi.

Andy Clifton presented different issues related to the technology from the side of academia.

The last presentation of the day was given by Breanne Gellatly representing an FLS provider. Originally that presentation had been planned for Day 2 but was shifted due to the presenter's (un)availability. At the same time, it formed a bridge to the workshop's second day.

A list of identified gaps and requirements to close these gaps is given in Table 1.

Table 1: Collected gaps and requirements from Day 1.

Gaps		Requirements to close the gaps
1.	Unknown Uncertainty <ul style="list-style-type: none"> • Measurement Accuracy • Assessment 	<ul style="list-style-type: none"> • Common Framework
2.	Need for/ Type of Motion Compensation unclear	<ul style="list-style-type: none"> • 6 Degree of Freedom • For Higher Frequency Data
3.	No standard for Validation available	<ul style="list-style-type: none"> • Common Framework • Sharing of data
4.	Missing Alternative Validation Methods (Without Offshore Met Masts)	
5.	Insufficient Measurement of Turbulence Intensity	<ul style="list-style-type: none"> • Use 6-beam Sathe/Mann Scan Geometry offshore (has been done only onshore) cf. Phase1 WP 2.3 • Motion restriction • 3 beams intersecting at measurement point • Motion compensation
6.	Use of alternative lidar techniques unclear (e.g. scanning)	
7.	Lack of Reliability of the system	<ul style="list-style-type: none"> • Improve reliability through redundancy (Power, Lidar,...)
8.	Insufficient System Specifications (Power, communication, data storage)	<ul style="list-style-type: none"> • Improve specifications
9.	Unclear Need for/ Type of System Classification (Relationship between motion characteristics and performance)	<ul style="list-style-type: none"> • Modeling of different sea states and buoy types (hydrodynamic) • Knowledge of weather limits
10.	Lack of Investor's Confidence	<ul style="list-style-type: none"> • Test and certify in accordance with an open protocol • Protocol should be: Open, Inclusive, Transparent, Collaborative • Include financiers in development of roadmap • Communicate about measurement campaigns • Better communication
11.	Missing Exchange of Practical Experience	<ul style="list-style-type: none"> • Central repository • Full transparency of data • Better communication • Share transferrable Experience • Include financiers in development of roadmap • Communicate about measurement campaigns
12.	Need for /Type of In-situ Monitoring	Trusted concepts for on board met systems
13.	Lack of suitable test facilities	
14.	Insufficient Maturity of mooring concepts	
15.	Lack of Common Understanding of commercial readiness of FLS (~"stage 3")	<ul style="list-style-type: none"> • Meaningful acceptance criteria related to real-world requirements (as described in appropriate lidar use cases)
16.	Lack of Market Knowledge/ no Shared Vision of the Market Size and Perspective	<ul style="list-style-type: none"> • Develop shared vision
17.	Lack of clarity over performance	<ul style="list-style-type: none"> • Recommended practices or standards • Type testing and certification
18.	Unsolved Operational Aspects (O&M, HSE, weight, mooring, licenses,)	
19.	O&M costs too high	

Day 2 – First Morning Session (Session 3)

For the first part of Day 2, the focus was set on the Floating Lidar technology itself. The six FLS providers represented during the workshop (five of them were left – Andy Paterson for Babcock, Arve Berg for Fugro OCEANOR, Thomas Lamant for EOLFI, Jorge García for EOLOS, and Bernhard Lange for Fraunhofer IWES) were invited to introduce their systems in a short presentation each. After these presentations, Julia Gottschall gave an overview of the technology based on the results of the list of questions sent out to all system providers in advance to the workshop. The technology review and the corresponding presentation, respectively, is also available on the workshop's website.

Day 2 – Second Morning Session (Session 4)

This session was again focussing on the gaps and requirements collected during Day 1. The participants were first asked to prioritise the points on the list prepared after the collection from Day 1 (see Table 1).

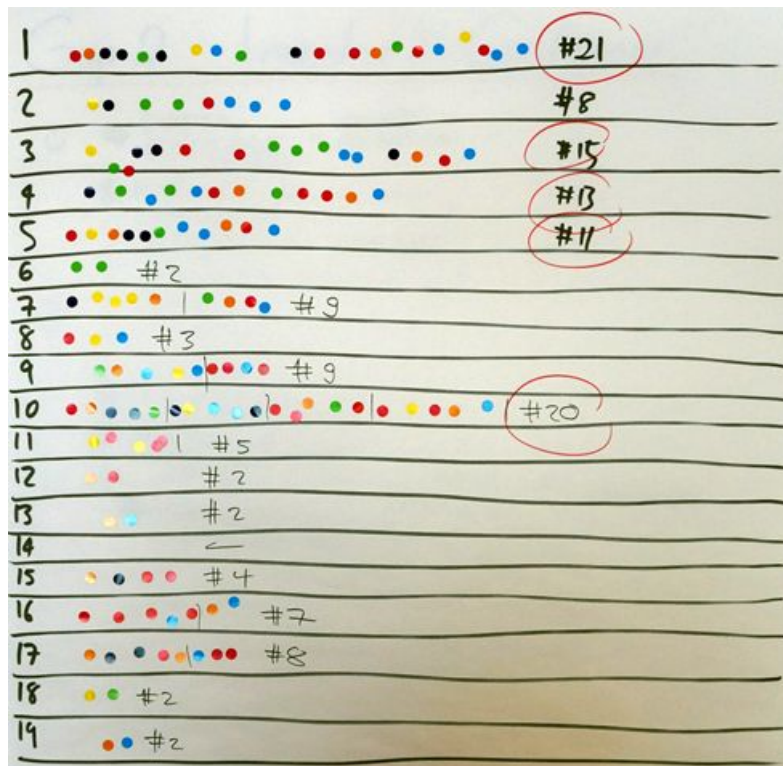


Figure 1: Selection of most relevant technology gaps.

From the prioritisation, the five most relevant present technology gaps (i.e. those with the most votes by the participants, see Figure 1) were selected for a deeper discussion. These were:

- Gap 1 – Uncertainty
- Gap 2 – Lack of investors' confidence
- Gap 3 – No standard for validation available
- Gap 4 – Missing alternative validation methods
- Gap 5 – Insufficient measurement of Turbulence Intensity

For the group work, four different groups were suggested:

Group 1

Andy Clifton, Andy Paterson, Adrian How, Simon Toft Sørensen, Matt Smith, Miriam Marchante Jiménez, (David Schlipf).

Group 2

Peter Clive, Nobuki Kotake, Yutaka Kajiyama, Mikiko Sasaki, Theodore Holtom, Arve Berg, Megan Smith, (Jonathan Hughes).

Group 3

Frank van Erp, Benny Svardal, Bernhard Lange, Matthieu, Boquet, David Langohr, Christian Jonsson, (Detlef Stein).

Group 4

Thomas Lamant, Will Laird, Hugo Herrmann, Jorge García, Rob Newsom, Hans Verhoef, (Ines Würth).

The groups were asked to concentrate on the five pre-selected gaps, and discuss how they can be tackled (as well as by whom and when). For each gap they should propose a corresponding roadmap.

Day 2 –Afternoon session (Session 5)

After the lunch break, the different draft roadmaps were presented by the individual groups (Table 2, 4, 6, and 8) and merged to joint roadmaps for each gap (Table 3, 5, 7, and 9). The corresponding outcome has been as follows.

Gap 1: Uncertainty

Table 2: Collected points from individual groups for Gap 1: Uncertainty.

What	Who	When
Merge IEC 61400-15 and Annex L	Everybody who is involved in the FLS community	6-9 months
Common framework for uncertainty with financial implications (P50/P90)	Task 32 (lead by ?Peter Clive)	Q1 2016
Define uncertainty components for EPA (including unknown/undefined components)	IEA Task 32 FLS group (author group with wide reviewers)	Complete by end 2016
Step by Step framework for Uncertainty (Annex L) taking into account Metocean (Base + Extreme) states	IEA Task 32, Project developers + researchers + project investors	12 months – start now
Gather existing practice	Lead by the „experienced“	3 months
Access (more) common data OR – Share the model and have the data-owners carry out the work Review data w.r.t. Annex L (identify sensitivities)	Need permission from operators – or „the Experienced“ to put together result (ECN/FNC/IWES/DONG/OWA)	3 months
Update draft of RP w.r.t. Uncertainty	RP Authors (with info from above)	After 6 months

Table 3: Merged roadmap for Gap 1: Uncertainty.

Timeline [months from now]		
0-3	Gather experience Models understanding	OWA sensitivity studies (ongoing)
3-6	Sanitized methods (technique not data); Improve methods Annex L	
6-9	New Task 32 RP kick-off	

Gap 2: Investors' confidence

Table 4: Collected points from individual groups for Gap 2: Investors' confidence.

What	Who	When
Communication (workshops, press, social media) of the growing body of evidence	Led by IEA task members	Continuous – start now
Common Database (links to all available documents)		3 months
Openness of Validation Reports		Continuous – start now
Aligned messaging from all stakeholders to investors. Message must be <i>Experience-based</i>	All stakeholders (with a common framework started by IEA)	Collect evidence now Workshops when evidence is present (after Summer 2016) Perhaps 12 months from there
Integrate the financial impact into design of trial rather than outcome of validation (aids conversations) „make it easy to incorporate into financial models“	Consultants/OEMs + Operators	Now, but ongoing
Condense all of our learning from other gaps	IEA Task 32	Continuously, but before the workshop
What undermines Investor Confidence? Must speak to investors to find out!	IEA Task (need to get the right people in the room)	Questionnaire or Workshop can be now, but beware of being half-baked (and unprepared)!
Press release about this meeting	Operating Agent	Immediately
Look at „financially tolerable“ uncertainty	RP Authors	Next update

Table 5: Merged roadmap for Gap 2: Investors' confidence.

Timeline [months from now]		
0-1	Press release, draft questionnaire	
1-3	Execute questionnaire Collect evidence, database Include finance info	
3-6	Results from questionnaire; Safety check for workshop	
6	Investors' workshop (← articulate outcomes from Gap 3, 4)	

Gap 3 + 4: Validation

Table 6: Collected points from individual groups for Gap 3+4: Validation.

What	Who	When
Create a validation framework which can accept deviations (but don't reinvent the wheel or contradict previous work) Separate data quality and operational performance? Include how to deal with Replacement Components (moorings, buoys, lidars, quality systems) Maintain Balance which is definitive but flexible and focused on Use Case	IEA Task 32	Q1 (into Q2) 2016
Generate FLS „Use Cases“ and confirm where validations are needed or have taken place. Ensure the FLS is „fit for purpose“ (foundations, EPA, etc.)	Peter Clive	
Step by Step validation method (incl. Reference, Sensitivity) Should be „audience focused“ – identify audience! Must tie-in with Uncertainty outputs/process	RP Authors + OWA/IEA working groups (with relevant experience)	6-12 months
Review Trusted Reference Source uncertainty as part of validation – including fixed lidars (incl. on-to-off shore)		
Ensure validation framework is a common approach, to ensure direct equivalency of reports		
Not just science, need to be transparent for investors		

Table 7: Merged roadmap for Gap 3+4: Validation.

Timeline [months from now]		
0-3	Validation framework Define use cases Align with RP document	Reviewing references Golden lidar Met tower ...
...	Review periods	
...	Checks	

Gap 5: TI measurements

Table 8: Collected points from individual groups for Gap 5: TI Measurements.

What	Who	When
Transfer existing TI work (NREL/DTU for OWA) to provide framework (generate, review, publicize) May need more knowledge	IEA Task 32, OWA	After 1,3,4 but duration 9 months
Review the „onshore issue“ then transfer to „fixed offshore“ Take lidar to lidar in the first step	Academics, Lidar suppliers	Duration of 2 years, starting now
Turbulence is measured differently by different technologies, so investigate alternative methods (6 beam Sathé/Mann equation). Breakdown the problem for moving lidars, see if lidar motion can be used to benefit results	Academic with a dataset	
Define what is needed and meant by „Turbulence“	WTG OEMs, developers, certification bodies	12 months at the Loads Workshop?
Consider using a different type of lidar as TRS for validation (dual Doppler scan on-to-offshore)		
Carry out comparisons with data to date	IEA Task 32	
Centrally reference all studies with discussion forum	IEA Task 32 OA	

Table 9: Merged roadmap for Gap 5: TI Measurements.

Timeline [months from now]		
0-3	Transfer existing knowledge	Define what is needed R&D
3-6	Task 32 library + forum	
12	OEM TI workshop	

Around 15:00 the workshop was concluded with some final remarks and the announcement of the next steps. The presentations will be made available on the Task 32 website together with these minutes in a password-secured area. A post-workshop questionnaire will be distributed to the participants for general feedback and some input for the upcoming workshops in Task 32. Furthermore, it is planned to summarize the outcome of the workshop in a technology review/update report to be published for a broader community.